**To:** Wands, James[James.Wands@hdrinc.com]
**Cc:** Garland, Edward[Edward.Garland@hdrinc.com]; Vaughn, Stephanie[Vaughn.Stephanie@epa.gov]; Kirchner, Scott[KirchnerSF@cdmsmith.com]; Naranjo, Eugenia[Naranjo.Eugenia@epa.gov]; John Connolly[jconnolly@anchorqea.com]; Peter Oates[poates@anchorqea.com]; Wen Ku[wku@anchorqea.com]; Robert Law[rlaw@demaximis.com]
**From:** Peter Israelsson
**Sent:** Thur 2/26/2015 3:18:05 AM
**Subject:** RE: Particle mixing rate question

James –

Thanks for the email. Responses to your questions are provided below. I apologize for the delay in getting back to you.

Please let us know of further questions.

Regards,

Peter

***1) I am still having trouble locating the spreadsheets with the correct version of the partitioning calculation from CARP used to generate the inputs to the model. There were many versions that were worked on by multiple individuals ~9 years ago. I apologize that I have not been able to find the correct version yet.***

Thanks for the update. Please let us know when this becomes available, so that it can be incorporated into our hv-CWCM partitioning analysis.

***2) I have a concern with the fluff layer averaging in the model. I appreciate the idea behind the depth averaging, but what about a case where the fluff layer is only present for a brief time. The depth weighted average would carry a depth weighted average concentration from the time the layer was present over the entire averaging period, and the bioaccumulation model will not see***

***that that concentration was not present for most of the averaging period, it will simply see the concentration. Please see the simplified example below. Any thoughts on how to address this?***

This is a good point with regard to the calculation of the average concentration of the fluff layer, which has some room for discussion. As you point out, the fluff concentration in the present model output reflects the mean concentration while the fluff layer is present.

For the bioaccumulation model inputs, the fluff layer concentrations are not passed directly but are rather embedded in the mean concentrations of the near-surface sediments for the exposure depth selected for that model. The bioaccumulation model is presently passed the mean concentration of the interval defined as the top 2 parent bed layers plus the fluff layer:

Cavg = ( {C2*H2} + {C1*H1} + {Cfluff*Hfluff} ) / {H2+H1+Hfluff}

where:

/□□□□□□□□ C2, H2 = concentration and thickness of layer 2, respectively

/□□□□□□□□ C1, H1 = concentration and thickness of layer 1, respectively

/□□□□□□□□ Cfluff, Hfluff = concentration and thickness of the fluff layer, respectively

/□□□□□□□□ {} = 24 hr mean

This averaged concentration corresponds to the top 1.5 to 3.1 cm of the bed, given that the thickness of the top two parent bed layers varies between 1.5 and 3 cm, and the fluff layer varies between 0 and 1 mm (in the code settings transmitted in Dec 2014). The layer-averaged concentration is also subject to horizontal averaging across the bioaccumulation model's segments. The thickness weighting in the above equation allows for the correct contribution of fluff mass to the layer-averaged concentration because Hfluff = 0 when the fluff layer is not present. Moreover, it is noted that the fluff layer generally has minimal impact on the above layer-averaged concentration because it is thin ($\leq$ 1mm) relative to the thickness of the top 2 layers of the parent bed (1.5 to 3.0 cm). This was demonstrated by processing sensitivities in which the fluff was excluded from the averaging, which yielded highly similar average concentrations.

Hopefully this conveys how the fluff layer averaging issue is handled at this time, but please let us know if we are not adequately addressing your question.

***3) Is it the case that the dissolved and particulate phases are never calculated in the fluff layer in the code?***

Correct, they are not needed for the chemical flux in the fluff layer: the chemical erosion flux is calculated from the cohesive erosion velocity, and mass exchange between the parent bed and fluff layer is specified on a total concentration basis. These latter exchanges are handled via analytic expressions (to allow us to handle such thin layers). Please see [4] and [5] below for more details.

***4) Is it also the case that there is no diffusive and particle mixing exchange between the fluff layer and the water column or bedded sediments?***

The chemical mass exchange due to diffusion and particle mixing between the parent bed and fluff layer is calculated by an analytic solution using a single mass-transfer rate. Due to the instantaneous equilibrium partitioning assumed in the bed, the carbon gradient between the fluff and parent bed not being resolved, and the mathematical formulation of the flux, it does not matter whether the gradient is specified on a total concentration or dissolved concentration basis. Dissolved exchange also occurs between the parent bed and the water column (although the code has been subsequently modified to prevent this exchange when the fluff layer is present). We did not include a dissolved flux from the fluff to the water column as this flux would be expected to be small relative to the erosion flux, given the residence time of the fluff layer.

***5) The only fluff layer interactions are deposition into fluff layer from the water column, erosion from the fluff layer to the water column, and deposition from the fluff layer to the bed, correct?***

In addition to the processes that you mention here and the previously described exchange with the parent bed (see [4] above), there is a thickness transfer of fluff to the parent bed. This term is explained further below.

In order to get the resolution that we felt necessary to model fluff dynamics, we conceptually define "fluff" as the material going up and down over the tidal cycle. The fluff layer thickness is not necessarily constant in space or time as it depends on the distribution of shear stresses. To allow the CFT code to adapt to the amount of intertidal erosion/deposition experienced at a given location, we added a one-way transfer of fluff mass to the parent bed with a simple exponential function, i.e., the fluff thickness decays and the material is gradually transferred to the parent bed. This was added to guard against the case, for example, where the fluff layer grows to 1 mm thick in the CFT model due to a deposition event, but the subsequent fluxes from the HST model correspond only to a bed thickness oscillation of 0.1 mm for an extended period of time. In the absence of a fluff thickness decay in this example, there would be 0.9 mm of static fluff thickness that could equilibrate with the parent bed due to the diffusive chemical exchange described above in [4]. This equilibration would eventually result in fluff chemical concentrations and erosion fluxes similar to those that would be realized if the fluxes came directly from the parent bed (i.e., as if there were no fluff layer). The decay rate is currently small relative to the timescale for intertidal deposition/resuspension, making the term less influential.

***6) Diffusion occurs between the top layer of the bedded sediment and the water column with no interaction with the fluff, correct?***

Yes, that's correct in the code version that was transmitted. Subsequent modifications have this flux occurring only when there is no fluff present, as noted in [4] above.

**Peter H. Israelsson, PhD**

**ANCHOR QEA, LLC** | www.anchorqea.com

**From:** Wands, James [mailto:James.Wands@hdrinc.com]
**Sent:** Thursday, February 12, 2015 11:59 AM
**To:** Peter Israelsson; Peter Oates
**Cc:** Garland, Edward; Vaughn, Stephanie (Vaughn.Stephanie@epa.gov); Kirchner, Scott; Naranjo, Eugenia (Naranjo.Eugenia@epa.gov)
**Subject:** RE: Particle mixing rate question

Peter and Pete,

I just wanted to touch base with you guys on a couple of items.

1) I am still having trouble locating the spreadsheets with the correct version of the partitioning calculation from CARP used to generate the inputs to the model. There were many versions that were worked on by multiple individuals ~9 years ago. I apologize that I have not been able to find the correct version yet.

2) I have a concern with the fluff layer averaging in the model. I appreciate the idea behind the depth averaging, but what about a case where the fluff layer is only present for a brief time. The depth weighted average would carry a depth weighted average concentration from the time the layer was present over the entire averaging period, and the bioaccumulation model will not see that that concentration was not present for most of the averaging period, it will simply see the concentration. Please see the simplified example below. Any thoughts on how to address this?

3) Is it the case that the dissolved and particulate phases are never calculated in the fluff layer in the code?

4) Is it also the case that there is no diffusive and particle mixing exchange between the fluff layer and the water column or bedded sediments?

5) The only fluff layer interactions are deposition into fluff layer from the water column, erosion from the fluff layer to the water column, and deposition from the fluff layer to the bed, correct?

6) Diffusion occurs between the top layer of the bedded sediment and the water column with no interaction with the fluff, correct?

Fluff Layer averaging:

| Hour | Concentration | Thickness | C*H | Cumulative C*H | Cumulative H |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 0.5 | 0.5 | 1.5 | 1.5 |
| 3 | 1 | 0.25 | 0.25 | 1.75 | 1.75 |
| 4 | 0 | 0 | 0 | 1.75 | 1.75 |
| 5 | 0 | 0 | 0 | 1.75 | 1.75 |
| 6 | 0 | 0 | 0 | 1.75 | 1.75 |
| 7 | 0 | 0 | 0 | 1.75 | 1.75 |
| 8 | 0 | 0 | 0 | 1.75 | 1.75 |
| 9 | 0 | 0 | 0 | 1.75 | 1.75 |
| 10 | 0 | 0 | 0 | 1.75 | 1.75 |
| 11 | 0 | 0 | 0 | 1.75 | 1.75 |
| 12 | 0 | 0 | 0 | 1.75 | 1.75 |
| 13 | 0 | 0 | 0 | 1.75 | 1.75 |
| 14 | 0 | 0 | 0 | 1.75 | 1.75 |
| 15 | 0 | 0 | 0 | 1.75 | 1.75 |
| 16 | 0 | 0 | 0 | 1.75 | 1.75 |
| 17 | 0 | 0 | 0 | 1.75 | 1.75 |
| 18 | 0 | 0 | 0 | 1.75 | 1.75 |
| 19 | 0 | 0 | 0 | 1.75 | 1.75 |
| 20 | 0 | 0 | 0 | 1.75 | 1.75 |
| 21 | 0 | 0 | 0 | 1.75 | 1.75 |
| 22 | 0 | 0 | 0 | 1.75 | 1.75 |
| 23 | 0 | 0 | 0 | 1.75 | 1.75 |
| 24 | 0 | 0 | 0 | 1.75 | 1.75 |
| Average | 1 | 0.072917 | | | |

Thanks,

James

**From:** Wands, James
**Sent:** Wednesday, January 21, 2015 11:56 AM
**To:** Peter Israelsson; Peter Oates
**Cc:** Garland, Edward (Edward.Garland@hdrinc.com); Vaughn, Stephanie (Vaughn.Stephanie@epa.gov); Kirchner, Scott
**Subject:** Particle mixing rate question

Peter, Pete,

I am looking at the particle mixing in the contaminant model runs that we received in December. I see that you have implemented 3D particle mixing rates in the bed and the implementation in the code appears to work correctly. I had a question about the input parameterization for the mixing rate. Looking at the inputs it appears there are two distinct profiles for vertical mixing in the model runs we are looking at. Both are identical below 2 cm. One has the highest mixing at the surface and the other has zero mixing at the surface. In the attached figure there is a map on the left with model grid cells colored either red or blue, the center panel has the mixing rate plotted verses depth on an arithmetic scale, and the panel on the right is the same information repeated on a log scale axis. The color on the map indicates the profile used at that location. The red cells are locations where there is no mixing in the top 2 centimeters. You will have to zoom in to see some areas.

Is there a justification for zero mixing at the surface in the red cells, or is this potentially a mistake in the input deck?

Thanks,

James

James Wands, P.E.

*Senior Water Quality Modeler*

*Professional Associate*

***Please note new address and phone number***

HDR

1 International Boulevard

10th Floor, Suite 1000
Mahwah, NJ 07495
**T** 201.335.9300 **D** 201.335.9442
James.Wands@hdrinc.com

hdrinc.com/follow-us